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A change in tune: acoustic analysis of Malta's cicadas reveals 162-year-old misnomer

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ABSTRACT. For over 160 years, the cicadas inhabiting the Maltese Islands were assigned to the widespread European species *Cicada orni* Linnaeus. However, analysis of their calling song reveals with certainty that the taxon known to occur in the archipelago is, in fact, the sibling species *Cicada barbara* Stål.

KEY WORDS. *Cicada barbara*, *Cicada orni*, Maltese Islands, new record.

INTRODUCTION

For centuries, the distinctive call of hundreds of male cicadas has characterized summer in the Maltese Islands, as it does elsewhere in the Mediterranean. Indeed, those responsible for this "summer song" have been mentioned in very early literature related to Maltese insects. Perhaps the very first mention of cicadas inhabiting the Maltese archipelago comes from the writings of the English explorer George French Angas in "*A Ramble in Malta and Sicily, in the Autumn of 1841*", where he writes of an excursion to Mellieħa in August of that year:

'*The foliage around was rich and beautiful, the cicada sang long and loud from the dark green carob and fig trees…*'

However, the cicadas of Malta were not specifically identified, or at least an attempt made thereof, until the work of Gulia (1858), who states (in Italian): '*Two Maltese species are known to me. The largest is Tettigonia Orni of Fabricius, and the other, much smaller and bearing a ferruginous abdomen, is the Cicada aestuans of naturalists'*. Whether or not Gulia's identifications can be trusted is a matter which has been discussed elsewhere for other insects (e.g. Cameron & Caruana Gatto, 1907; Mifsud, 2000). Surprisingly however, especially for such a large and noticeable insect, no other entomological attempt to identify Malta's cicadas was made for another 154 years, when D'Urso & Mifsud (2012) confirmed the presence of *Cicada orni* on the basis of morphological examination. It must be said that *Cicada orni* is indeed mentioned in literature before that (e.g. Cilia (1980), Sultana & Gauci (1980) and Mifsud (2000)), but these works cite no material and refer to no literature on the basis of which such as species identity can be safely assumed. Perhaps this assumption was based on Gulia's mention of "*Tettigonia Orni*"; if not, its basis is otherwise unknown.

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In the present work, for the first time, identification of Malta's cicadas was also carried out through acoustic analysis and not only via morphology alone, revealing that their long-standing identity as *Cicada orni* is in fact mistaken.

MATERIAL AND METHODS

For the sound recordings of singing male cicadas from Malta we used an Olympus Tough TG-5 compact camera. The song was extracted from the original video recordings (MOV) using VideoPad (NCH Software). For sound analyses, Raven 1.5 (Cornell Lab of Ornithology), Audacity 2.4.2 (open source), Wave Pad (NCH Software), and the Seewave package (Sueur *et al.*, 2008) as part of R statistical software were used. Spectrograms and oscillograms were compared to those obtained from known *Cicada* songs (e.g. Gogala, 2007-2020).

RESULTS

Considering the possibility of a mistaken identity of the *Cicada* inhabiting the Maltese Islands, the cicada collection of Slovenian Museum of Natural History was examined. In the mentioned collection, a male specimen designated as *Cicada barbara* was found (Collection data: 2.ix.1997 from Andrej Kapla and donated to the museum), the identification of which was based on its song (A. Kapla, *pers. comm*., 2020).

In July 2020, video recordings of *Cicada* inhabiting the Maltese archipelago were made, from which the audio for song analysis was extracted, and it was found that the singing on the recordings (Fig. 1) were actually due to *Cicada barbara*.

Later, examination of *Cicada* specimens from the following collections: the National Museum of Natural History (**NMNH**) in Mdina (Malta); the joint private collection of David Mifsud and Thomas Cassar (**DMTCC**), the private collection of Anthony Seguna (**ASC**) and the Slovenian Museum of Natural History (**PMSL)** was also carried out.

Cicada barbara Stål, 1866

(Fig. 2)

Material examined. MALTA: Sliema (35.918412°N, 14.499126°E); 2.ix.1997, collected 1♂ (PMSL), heard, leg. A. Kapla; Żejtun (35.854871°N, 14.536397°E), 10.viii.2002, collected 1♂, leg. D. Mifsud; Msida (35.895639°N, 14.486888°E), vii.2020, recorded, T. Cassar; Baħar iċ-Ċagħaq, 13.ix.1970, collected 9 exs. (NMNH), leg. G. Lanfranco; Rabat, 4.viii.1979, collected 1 ex. (NMNH), leg. G. Lanfranco; Naxxar, 12.viii.2000/31.vii.2001, collected 2 exs. (ASC), leg. A. Seguna; St Paul's Bay (San Martin area) (35°56'06.5"N 14°22'54.4"E), 30.viii.2020, 10♂♂ & 2♀♀ (DMTCC), leg. T. Cassar; Selmun (35°57'33.6"N 14°22'42.5"E), 23.viii.2020, collected 4♂♂ (DMTCC), leg. T. Cassar; Żebbuġ 35°52'03.7"N 14°26'19.9"E), 23.viii.2020, collected 1♂ (DMTCC), leg. C. Aldo; Mellieħa (Marfa) 35°59'12.4"N 14°20'55.8"E), 29.vii.2015, collected 1♂ (DMTCC), leg. T. Cassar. **COMINO**: close to Blue Lagoon 36°00'54.5"N 14°19'31.8"E), 17.ix.2020, collected 1♂ (DMTCC), leg. D. Mifsud & T. Cassar. **GOZO**: Sannat (Ta' Ċenċ) (36°01'18.1"N 14°15'14.1"E), 2.x.2020, collected 1♂ (DMTCC), leg. T. Cassar.

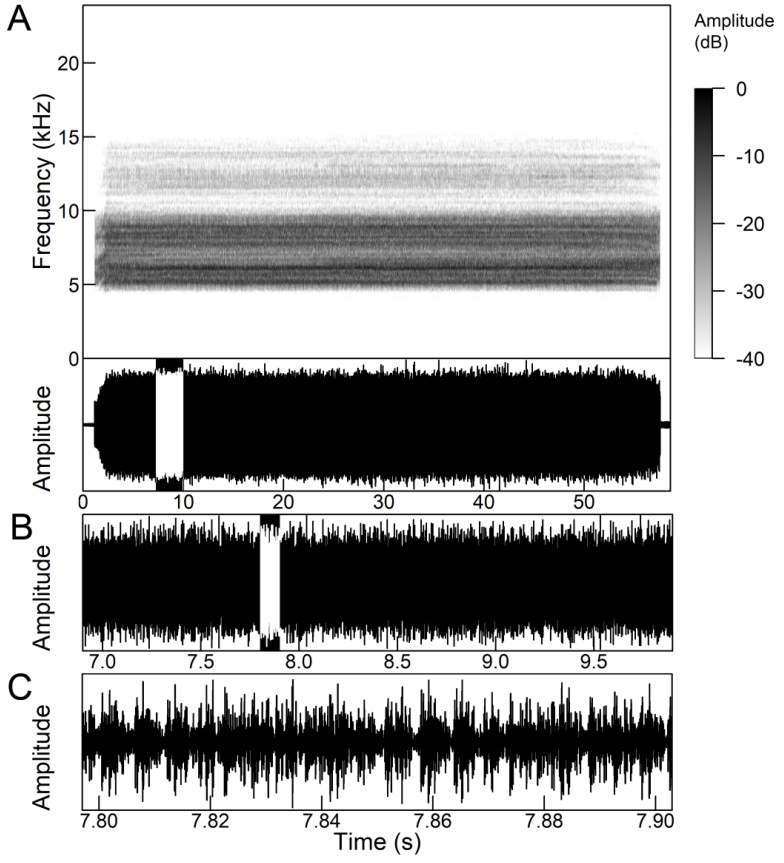

Figure 1: Calling song of *Cicada barbara* (A) spectrogram (time vs. frequency vs. amplitude, amplitude scale is given on the right) and oscillogram (time vs. amplitude) of the calling song; (B) oscillogram of the enlarged part corresponding to the inverted window in (A); (C) oscillogram of the enlarged part corresponding to the inverted window in (B).

DISCUSSION

There are seven species of *Cicada* in the Mediterranean: *Cicada barbara* Stål 1866, *C. cerisyi* Guérin-Méneville, 1844, *C. cretensis* Quartau & Simões, 2005, *C. lodosi* Boulard 1979, *C. mordoganensis* Boulard 1979, *C. orni* Linnaeus 1755 and *C. permagna* (Haupt, 1917). *Cicada cretensis* is an endemic of the Greek island of Crete (Quartau & Simões, 2005), while *C. lodosi* and *C. permagna* are distributed only in Anatolia (Sanborn, 2014) and *C. mordoganensis* also has a relatively restricted distribution in southern Anatolia and East Aegean Islands (Trilar *et al*., 2020). *Cicada cerisyi* is known from Egypt and Libya (Sanborn, 2014). *Cicada barbara* is distributed in the western Mediterranean area (Iberian Peninsula, Italy (including Sardinia and Sicily)) and northern Africa (Morocco, Algeria, Tunisia and Libya) (Sanborn, 2014). In the Iberian Peninsula, this species has a distinct subspecies *C. barbara lusitanica* Boulard, 1982, which differs in genital morphology from the nominate subspecies. The most widely distributed species is *C. orni*, whose range extends from central and southern Europe and northern Africa, the entire Mediterranean region

Figure 2: *Cicada barbara* Stål, 1866 (Malta)

up to the Middle East, Transcaucasia and Middle Asia (Duffels & Van Der Laan, 1985; Sanborn, 2014; Trilar *et al*., 2020). Some *Cicada* species have been recorded in sympatric populations with *C. orni* in different areas of its distribution. This is also true for *C. barbara*, which is sympatric with *C. orni* in the westernmost part of its range (Simões & Quartau, 2009).

Morphologically *C. orni* and *C. barbara* are very similar and it is very difficult to distinguish the two species on the basis of external morphology alone especially if few specimens are available for study. There are some differences in genital morphology such as the size of the dorsal spine of the pygofer, which is larger in *C. orni* (Quartau & Simões, 2006). The most reliable distinguishing characters are the acoustic signals. Besides the obvious differences in the fine structure of the signals (Quartau & Simões, 2006), the difference in song composition is also visible/audible and can even

be distinguished by the naked ear. While the calling song of *C. barbara* is a continuous, monotonous and long-lasting single-echeme, the calling song of *C. orni* consists of a pattern of regular repetitions (5-8 times per second) of echemes and interecheme intervals, where the echemes are composed of a variable number of groups of pulses (e.g. Trilar *et al*., 2020). In the present acoustic survey in Malta, we only recorded *C. barbara*, therefore there are no acoustically confirmed data on the occurrence of *C. orni* in Malta.

In these last decades, the entomofaunistic knowledge in the Maltese Islands has skyrocketed with publications on previously poorly studied insect groups, including many new records for the area and sometimes even descriptions of new species. Despite all these efforts, probably the most common insect found anywhere on the Maltese Islands during the summer season, and probably the insect most often mentioned in social media and local popular press, our local cicada, was based on an incorrect scientific name for over 160 years.

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